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EXPERIMENTAL STUDY ON A SPARK IGNITIO ENGINE FUELLED WITH PETROL AND N-BUTANOL BLENDS

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ABSTRACT

An Experimental study was carried out on a Twin cylinder, Car-Spark Ignition Engine with MPFI fuel system, then the Engine Runs at the constant speed of 2500rpm for all loads, Fuelled with petrol and n-Butanol blends at different proportions i.e. Bu0, Bu10, Bu35 and neat n-Butanol (Bu100). All blends are by volume based Proportions. The Engine Performance parameters such as fuel consumption, Brake thermal Efficiency, Emission parameters like CO, CO_2, NO emission readings were analyzed and discussed at Full load and partial load for different fuel blends. The Experimental results showed an increased brake thermal efficiency and reduced fuel consumption, CO and NO Emission levels are reduced for blended fuels when compared with pure petrol at both Full load and partial loads. From the analysis, n-Butanol is found to be a better alternative fuel (or) fuel blend to petrol for Improvement in SI Engine performance and Reduction of polluting Emissions.

***KEYWORDS:** n-Butanol, Alcohols, Butanol-Gasoline Blend, Performance, Emission & Alternative Fuels*

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Original Article

INTRODUCTION

Butanol is a longer chain hydrocarbon and it has a four- link hydrocarbon chain. It is Produce from biomass (as “Bio-Butanol), as well as fossil fuels (as “Petro-Butanol”), the Bio-butanol and Petro-butanol and it’s having same chemical properties. The butanol can be used in vehicles with petrol without any modification of the engine. So the butanol can be used as an additive fuel with petrol in SI Engine’s Operation. Butanol produces more power per liter than ethanol as with gasoline. So it can use as a transport fuel. As per the energy policy of Act 1992, the Bio-butanol blends of 85% (or) more petrol, can be used an alternative fuel. Bio-butanol is having high energy content but little lesser to petrol. Bio-butanol having the ability to reduce green house gas emission level. At present Ethanol at millions of gallons was added with petrol, but ethanol is having lower energy content per gallon as compared to petrol. But butanol is having 30% more energy content per gallon as compared with ethanol. So the Butanol (or) the Bio-butanol can be blended with petrol up to the optimum level, without any modification of the engine. So, the butanol is a much better fuel blend (or) an alternative fuel along with petrol, so the butanol’s emerging reputation as “the gasoline of the future”.

BACKGROUND

Neat n-butanol reduced the tendency to knock. Engine torque can be improved at full load with n-butanol as compared to gasoline. By the use of butanol general decrease in NO_x Emissions significant change in CO Emissions. The knock limited spark timings were more advanced because of the reduction in the charge temperature with butanol. This enabled higher torques to be achieved [1]. The use of N-Butanol improves the

torque and efficiency at higher throttle position. Injecting n-butanol just before the start of injection of gasoline is beneficial for reducing HC and CO emissions than simultaneous injection. Engine performance also improves with the use of butanol at a wide range of operating conditions and the ratio of the fuels can be varied [2]. Positive results have been achieved in the engine torque, BSEC, CO emission and HC emission with 35% volume butanol and 1% H_2O addition, combined with using the modified ignition timing. But NO_x and CO emissions go up. The influences of butanol–gasoline blend on engine performance, fuel economy and emissions have the same trend at engine full load and partial load [3]. Use of pure N-butanol, (i) HC, CO Emissions and decreases NO_x and particle number concentration compared to those of gasoline. (ii). Specific HC, CO and NO_x emissions fueled with gasoline and n-butanol blends are lower than those of gasoline [4]. Due to N-butanol Volume Fraction, 1. Autoignition (timing) of the fuel advances, 2. Aldehyde's concentration is high, 3. Combustion duration is decreased [5]. It is concluded that maximum effective power and minimum pollutant produced only in B25 fuel. In future sterculia foetida seeds, biodiesel production is effortless and very effective for diesel engine operations without any modifications in the engine [6]. It is found that the average percentage eviation for the manual mathematical model is lesser than the Minitab software generated a model. It is because of, the Minitab software considers the equation for the mathematical model is of polynomials of Single order equation, but the manual mathematical model considered in this work is polynomials of third order equation. Therefore the error has been squared in the manual mathematical model than the software model [7]. The present work proved that the 5% of alcohol fuel blend with 25% of biodiesel and diesel produced maximum efficiency and minimize the exhaust emission level compared with 10% of alcohol blend and base diesel [8]. It is concluded that solid surface reaction method reduced HC, CO, CO2, and O2. However, NOx level is increased. In this result clearly mentioned further research work required to analyze the surface reactant contacting area, reaction time and reaction temperature [9]. Reducing HC,CO,$CO_{2,}$ Emissions for the fuel blend of IB30% is much Optimized blend as compared to Baseline and other fuel blends at both Engine Load Conditions [10].

Blending Method

For my project, I took the blends of Bu0, Bu10, Bu35 and neat n-Butanol (Bu100). All the blends are by volume based mixed proportions. Here Petrol is blended with butanol, after it is kept into airtight crucible. Then it was kept in a rotator. All the blends are divided in too many small blends. Then the crucible was kept on the rotary rotator. Initially, it looks like two different layers when the blending ratio was increased that time the small, small precipitation layers can seem in the fuel. Before start blending the butanol with petrol, if butanol was added more and more like Bu0, Bu10, Bu35 and neat n-Butanol (Bu100) the white precipitation color can seem clearly. "It indicates that the volume fraction will occur in between the butanol and petrol". Then the rotator starts to rotates up untill we required to get the uniform layer throughout the whole fuel. It indicates the butanol will be well blended with petrol. Crucible top was covered with air-tight cock. So, there is no vaporization will takes place.

Fuel Properties

Table 1: Properties of Petrol, n-Butanol

Property	Petrol	n-Butanol
Chemical Formula	$C_4 – C_{12}$	C_4H_9OH
Calorific value (kJ/kg)	43300	33100
Density(kg/m$^{3)}$	739	803
Octane no	95	88
Boiling temperature(˙c)	26 - 210	116

SPECIFICATION OF THE TEST ENGINE

Engine Type	:	2cylinder, 624cc, MPFI
Bore and Stroke	:	73.5mm & 73.5mm
Compression Ratio	:	9.7:1
Allowable Torque	:	30.6Nm @ 2500Rpm
Speed (Constant)	:	2500Rpm
Fuel Supply System	:	MPFI
Loading Device	:	Eddy current dynamo

Figure 1: Test Engine

Figure 2: AVL Emission Gas Analyzer

Experimental Work on Test Engine

For my project work, I took for four strokes, two cylinders, with MPFI car spark ignition engine. Here the engine flywheel was coupled with eddy current dynamometer loading by the way of the universal joint. Water type radiator cooling system was used here. The 12v battery was used here for starting the engine. This is electrically connected with starting a motor. On top of the weighing scale, one small fuel tank was kept. One fuel line was taken from that tank inlet, and the outlet of the line was connected to the filter, and followed by finally, it is connected with fuel pump and with the MPFI system.

Then start the engine and needs to initially flush with pure petrol. Note the scale reading with petrol. Start to apply the load from no-load to full load. Then take the baseline reading of petrol for the load conditions of 0%, 20%, 40%, 60%, 80%, and 100% for every loading of the engine how much fuel consumption is consumed by the engine per minute have to be noted simultaneously CO,CO_2, NO. The readings will be available in terms of kg/min for every loading the exhaust gas emission reading also have notified by the helpful of the AVL-DI gas analyzer. I.e. like the readings for Bu0, Bu10, Bu35 and neat n-Butanol (Bu100). The advantage of this MPFI system, this system will take care of how much amount of A/F mixture is required for the combustion based on load & speed of the engine and with other engine parameters, and at the correct time, optimum level of AIF mixture goes to the engine cylinder at the every suction time by through the inlet valve.

RESULTS AND DISCUSSIONS

Fuel Consumption

For Full Load

- Decreasing fuel consumption 12.82% for the blend of BU10 as compared to the baseline reading of petrol.
- For the blend of BU100 provides 7.2% fuel consumption is lesser than the baseline reading.

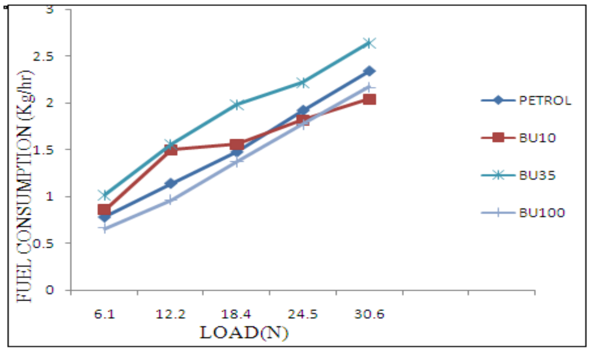

Figure 3: Fuel Consumption

For Partial Load

- Petrol provides best fuel consumption at partial load as compared to all other fuel blends.
- For the blend of BU100 provides 6.7% fuel consumption is lesser than the baseline reading.

Brake Thermal Efficiency

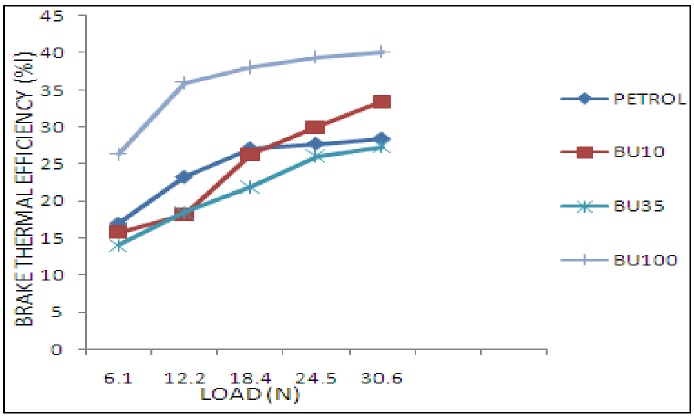

Figure 4: Brake Thermal Efficiency

For Full Load

Increasing Brake thermal Efficiency at 14.89% and 29.11% for the blend of BU10 and BU100 as compared to the baseline reading of petrol.

For Partial Load

- Petrol provides best Brake Thermal Efficiency at partial load as compared to all other fuel blends.
- But for the blend of BU100 provides 28.7% Brake Thermal Efficiency is higher than the base line reading.

Emission Reduction Details For No, Co_2 and Co

Nitrogen Oxide (NO)

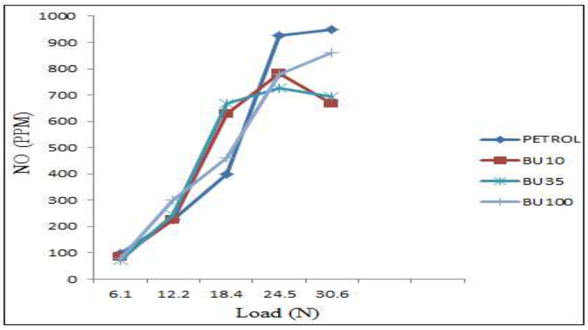

Figure 5: Nitrogen Oxide (NO)

For Full Load

Decreasing NO Emission at32.77% and 9.16% for the blend of BU10 and BU100 as compared to the baseline reading of petrol.

For Partial Load

Petrol is the best fuel for reducing NO Emission at partial load.

Carbon-di-oxide (CO_2)

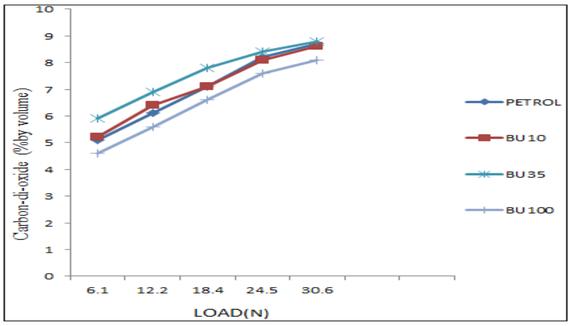

Figure 6: Carbon-Di-Oxide

For Full Load

Decreasing CO_2 Emission at1.147% and 6.896% for the blends of BU10 and BU100 as compared to the baseline reading of petrol.

For Partial Load

Petrol is the best fuel for reducing CO_2 Emission. But BU100 reducing CO_2 Emission 7% as compared to the baseline reading at partial load.

Carbon Monoxide (CO)

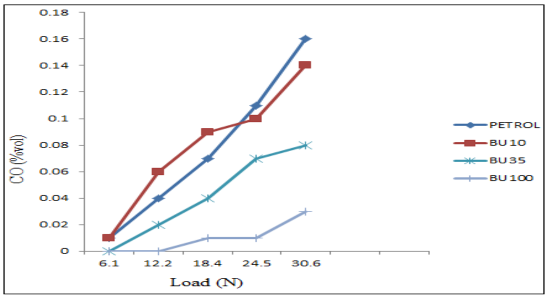

Figure 7: Carbon-Monoxide (CO)

For Full Load

Decreasing CO Emission at 81.25%, 50% and 12.5% for the blends of BU100, BU35, and BU10 as compared to the baseline reading of petrol.

For Partial Load

Decreasing CO Emission at 85.71% and 42.86% for the blends of BU100 and BU35 as compared to the baseline reading of petrol.

Exhaust Gas Temperature

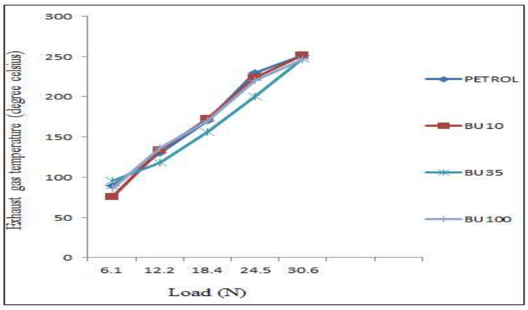

Figure 8: Exhaust Gas Temperature

- In full load at all the load conditions, the exhaust gas temperature is same.
- But in partial load, the decreasing exhaust gas temperature is less at 8.2% for the blend of BU35 as compared to the baseline reading of petrol.

CONCLUSIONS

As I was carried out the test on a Twin cylinder, Car - Spark Ignition Engine with MPFI fuel system, From Experimental Results I was found the following details:

At Full Load Condition

- For reducing fuel consumption (12.82%), NO (32.77%), CO_2, CO Emissions Reductions and Increasing Brake thermal efficiency (14.89%) for the fuel blend of "Bu10" is very best as compared to baseline readings of petrol.
- But neat n-Butanol (Bu100) also is better for reducing fuel consumption, CO (81.25%), NO, CO_2 Emissions reductions and Improving Brake thermal efficiency (29.11%) as compared to Petrol.

At Partial Load Condition

- For reducing fuel consumption, NO, and CO_2 Emissions reductions and Increasing Brake thermal efficiency, the neat Petrol is much opted as compared to all other fuel blends (or) Bio-butanol blends.
- But neat n-Butanol (Bu100) is also better for reducing fuel consumption (6.7%), CO (85.71%), CO_2 Emissions Reductions.
- As compared to Bu10 and Bu100, the “Bu35” is very good for CO emission reduction in both full load (50%) and Partial load (42.86%) as compared to the baseline reading.
- As I studied the above Experimental Results at both load conditions, Finally, I Concluded – the fuel blend of “Bu10” is the better alternative fuel (or) fuel blend with petrol for reducing fuel consumption, NO Emission reduction and Improving Brake thermal efficiency at higher than petrol without any modification of the Engine Design.
- But I have to little focus for Bu10 fuel blend, for CO and CO_2 emission reductions, but also Bu10 is much better than Petrol.

REFERENCES

1. *T. Venugopal[*], A. Ramesh Effective utilization of butanol along with gasoline in a spark ignition engine through a dual injection system. (Applied Thermal Engineering 59 (2013) 550-558).*
2. *T. Venugopal, A. Ramesh[*] Experimental studies on the effect of injection timing in a SI engine using dual injection of n-butanol and gasoline in the intake port. (Fuel 115 (2014) 295–305).*
3. *(Renhua Feng[a,b], Jing Yang[a], Daming Zhang[b]) Experimental study on SI engine fuelled with butanol–gasoline blend and H_2O addition. Energy Conversion and Management 74 (2013) 192–200*
4. *(Xiaolei Gu[a], Zuohua Huang[a,*], Jian Cai[a]) Emission characteristics spark-Ignition engine fuelled with gasoline n-Butanol blends in combination with EGR. (Fuel 93 (2012) 611–617)*
5. *Bang-Quan He[a,*], Mao-Bin Liu[a], Jie Yuan[a], Hua Zhao[a,b] Combustion and emission characteristics of a HCCI engine fuelled with n-butanol–gasoline blends. (Fuel 108 (2013) 668–674)*
6. *Dr. P.P. Sethusundaram[1], M.Vijayakumar[2], N. Prasanna[3] Effect of sterculia foetida biodiesel on singlecylinder four stroke diesel engine performance and emissions. (J o u r n a l o f A d v a n c e s i n c h e m i s t r y 12 (2016) 4614- 4622).*
7. *P.C. Mukesh Kumar[1], M.Vijayakumar[2], N. Prasanna[3] Mathematical Investigation on Emission of Bio-Diesel in Internal Combustion Engine. (International Journal for Scientific Research & Development 3 (2015) 274-277).*
8. *M.Vijayakumar[1], P.C. Mukesh kumar[2] Performance Enhancement and Emissions Analysis of Diesel Engine with Biodiesel, N-Propanol and 1-Butanol Blend. (Journal of Applied Fluid Mechanics 10 (2017) 79-84).*
9. *P.C. Mukesh Kumar, M. Vijayakumar Effect of post combustion treatment on diesel engine exhaust gas emissions. (Pak. J. Biotechnol. 14 (2017) 120- 124).*
10. *P.Baskaran Emission study on si engine fuelled with petrol and iso-butanol blends. Pak. J. Biotechnol. 14 (2017) 5-7)*